

SIM Lite Astrometric Observatory

Double Blind Search for Earths -4

IMPLICATIONS:

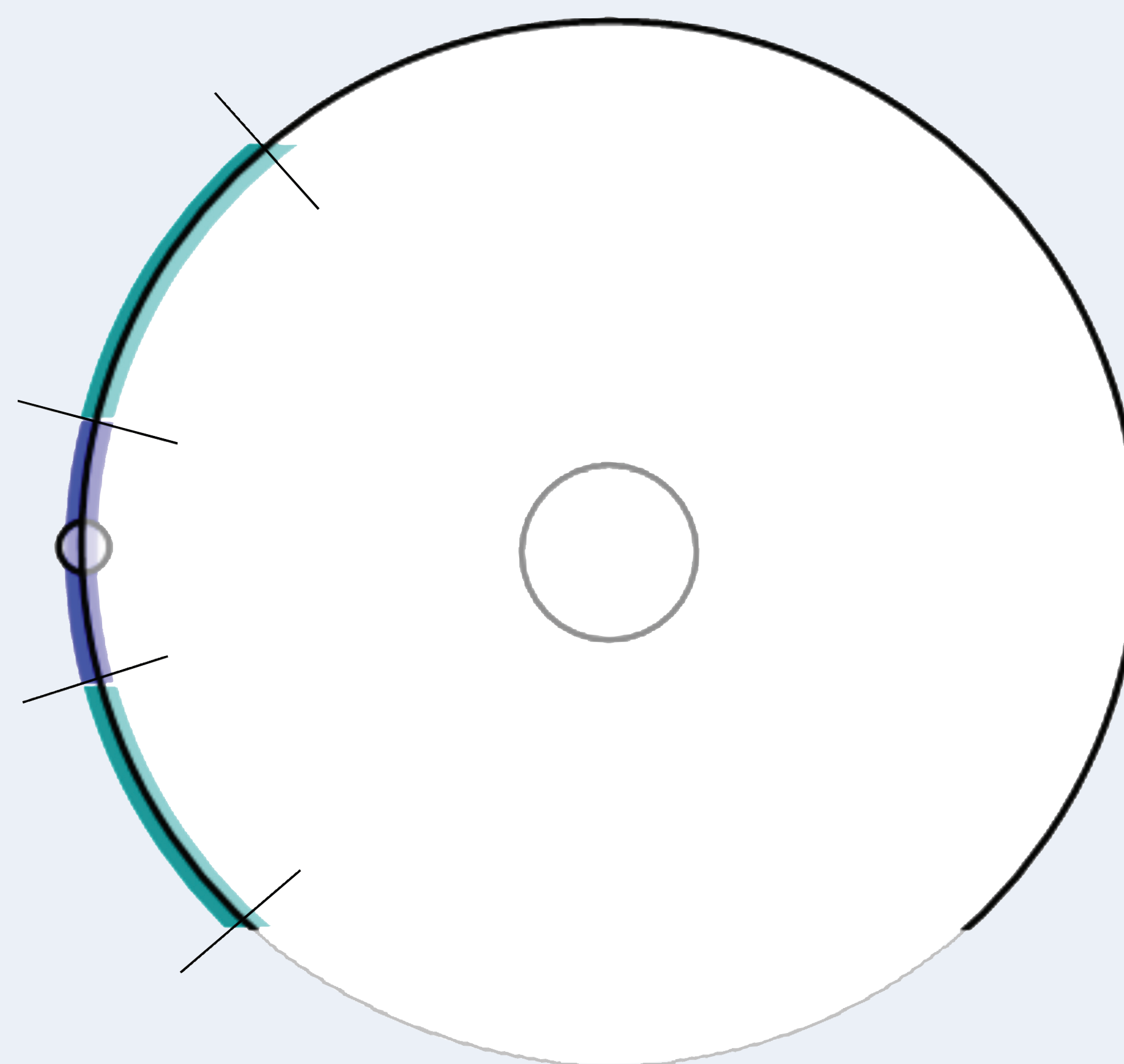
1. Astrometry — Imaging Synergy

Astrometry of Exoplanets

- At SNR~6 an astrometric orbit gives Period $\pm \sim 3\%$
- Error looks like an arc (see figure below)
- The phase error is ~ 0.25 rad at mid-epoch of the SIM Lite mission. To extrapolate to a later date:
 - $P_{\text{err}}(T) \sim \text{RSS}(0.25, T \cdot 3\% \cdot 2p)$
 - ~ 1 radian @ $T = 5$ yrs
- When to look:
 - At $T = 0$ range is ± 14 days
 - At $T = 5$ yrs range is ± 58 days
 - An astrometric orbit + 1 image of the planet 5 years later greatly decreases the orbital phase uncertainty (by almost 10X).

Imaging of Exoplanets

- There will be many planets; only a few will be Terrestrial (T) in the Habitable Zone (HZ).
- A precise planet orbit can be obtained by:
 - 4 images of the planet (3 to get orbit, 4th confirms all 4 images are of the same planet). 4 images of the planet will take ~ 12 images for Inner Working Angle (IWA) $\sim 0.7R_{\text{max}}$, or...
 - Astrometry + 2 images of the planet. Requires 4-5 images for Inner Working Angle $\sim 0.7 R_{\text{max}}$
- If $\eta_{\text{Earth}} \sim 10\%$ it is necessary to observe many stars many times to verify the planets are not T/HZ planets.
 - Reduce the number of images by $\sim 30\text{X}$ if $\eta_{\text{Earth}} \sim 10\%$ and $\sim 10\text{X}$ if $\eta_{\text{Earth}} \sim 30\%$.
- Astrometry informs us where we do and don't need to look for T/HZ planets. When IWA $\sim 0.7 \cdot R_{\text{max}}$ Earth is observable 32% of its orbit. The brightness of a planet with constant albedo varies by 3X over orbit. 3X albedo variation is $\sim 10\text{X}$ brightness change.



Astrometric Orbit Error

Blue – mid-epoch ($\sigma_r \sim 0.03$ AU), ($\sigma_\theta \sim 0.25$ radians)

Green – 5 years after mid-epoch

2. SIM Lite Search Space

- SIM Lite will find Earth-Analogs around nearby Sun-like FGK stars.

